BIO-DYNAMICS

A periodical furthering soil conservation and increased fertility in order to improve nutrition and health.

SUMMER 1958

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NUMBER 47

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R. D. 1, CHESTER, NEW YORK

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PROTEIN CHANGES DURING GERMINATION AND EARLIEST LEAF GROWTH

EHRENFRIED E. PFEIFFER

During germination and the earliest stages of leaf growth, the seedling undergoes tremendous biochemical changes. The seed proteins are broken down and the amino acids are re-combined, the carbohydrates are used as nutrient until the sprouting plant has developed the first leaves and photosynthesis begins. Sprouted grains are considered to be of special nutritious value, also because of the presence of numerous enzymes.

Our interest in the problem of feeding sprouted grains was aroused when a Russian friend demonstrated to us some 37 years ago a meal made from sprouted wheat. The wheat was soaked in water for 2 or 3 days, until the seed swelled up and became soft; then it was put into a frying pan and heated slightly with butter for a few minutes. This meal, served with honey, had the astonishing effect that a few tablespoonsful satisfied completely. We were told that it was the favorite dish of Russian peasants because of its simplicity and nutritious value.

In recent years the feeding of sprouted grains to livestock has been introduced in this country. A special apparatus was constructed in order to enable a farmer to sprout grains in a nutrient solution and allow them to grow for some 4-8 days until the leaves developed to a few inches' length. This grain, in the seedling state, can be fed as supplement to livestock and poultry with remarkable results. Some years ago Dr. C. F. Schnabel of Kansas City, Mo. showed us analyses of sprouted cereal grains when the plants had just reached the first joint stage and pointed out that the young plants had at that time the highest protein content, not to be reached before or after this definite period of their lives.

A commercially obtainable machine was produced by Niamco, Inc. of Dallas, Texas, called Herbagere to use sprouted grains as farm feed. The Buckeye Corp. of Springfield, Ohio has recently taken over the production of the Herbagere. Another machine apparently with the same purpose is Meadow-Master by H. and M. Manufacturing Co., Inc. of Denton, Texas. The tests reported in the following were made with a Herbagere, which Niamco, Inc. had kindly provided for research.

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The purpose of the research done in our laboratory was to establish data (a) on the protein development and supply and the amino acid pattern of grain germinated in the Herbagere under controlled conditions; (b) on the nutrient solution which promises the most favorable protein development during germination; (c) to determine the day of germination which promises the highest protein content.

The Herbagere, is a piece of equipment which facilitates the germination of seeds for feeding purposes. It contains several "decks" or pans containing the nutrient solutions. Perforated trays holding a thin layer of seeds, spread over the entire surface, are inserted into the pans so that the water just reaches the seed. Later on, the roots of the germinated seed protrude through the holes in the tray into the nutrient solution.

The moisture in the cabinet is regulated by a thermostatically operated fan. The circulation of the air is important because it will help to avoid the formation of molds due to stagnant air and saturated air moisture. However, in our tests from April through September 1957, we were not troubled with any mold contamination.

The model of Herbagere used by us has two glass doors on the sides, and the other two sides are made of an opaque transparent material. It is important that the seedlings receive as much light as possible once the seeds have germinated and begin to show leaves. The photosynthesis of protein is improved to the extent that the Herbagere is placed in a well lighted place. It is intended to check into the matter of light supply in some future experiments.

Germinating tests were made with wheat, oats and barley. The seeds came from a bio-dynamic farm and also otherwise excelled in good protein content and quality. The nutrient solutions used for the tests were as follows:

O = *control,* just plain tap water.

F = *formula,* a mineral completely supplemented product provided by the Herbagere manufacturer, described on the label as "Herbagere Nutrient Salts," one level tablespoonful for every 44 gallons of water.

C = an extract from a *compost made with the B. D. Compost Starter.* This compost was made from kitchen garbage, weeds, 60% by weight, manure 20% by weight, and good soil 20% by weight. The method of making the compost followed the routine description for the use of the B. D. Compost Starter.

The compost was well fermented, aged, air-dried. The analysis was as follows: Moisture 7.4%, organic matter 23.4%, total nitrogen 1.46%.

1 lb. of this compost was used per each 5 gallons of water. The suspension of said compost was stirred once before filling the tray pan but was not screened or filtered. The germinated seeds were analyzed on specific days of growth for moisture content by drying to weight constancy in an automatically regulated oven at 105°C. Then an analysis for protein was made, using the official AOAC method (factor 6.25 for calculation of protein from total N) and, finally, a chromatographic method for determination of free amino acids was made, using the descending method with methyl-ethyl-ketone 75 ml, propionic acid 25 ml, aqua dist. 30 ml, as eluent, eluent time 20 hours, and the ninhydrin reaction 0.3% alcoholic solution (ethanol 95%) was read after 4 and for 24 hours developing time.

The following amino acids could be determined with a quantitative estimate, comparing the findings with color standards of pure amino acids, for *wheat, barley* and *oats* (rye will be done at some later time): arginine, aspartic acid, glutamic acid, leucine, lysine, methionine, threonine, tyrosine, valine.

Discussion of Results:

All grains show a considerable fluctuation of the protein and amino acid contents from day to day, with maxima and minima.

Using the compost solution for germination:

For wheat: the peak was on the 6th day, a low spot on the 7th and 8th, then a rising curve starts again.

For barley: the peak was on the 4th day, a slow decline follows, with the low spot on the 7th day.

For oats: the peak was on the 6th day, with a low spot on the 4th day, a steep incline to the 6th day, a slow decline to the 9th day.

For rye: the peak was on the 5th day, with a low spot on the 3rd day, a steep incline from the 3rd to 5th day, a steep decline to the 8th day.

Using the formula solution for germination:

For wheat: peak on 4th day, steady decline to 8th day, small incline on 9th day, slight decline on 10th day.

For barley: peak is on the 5th day with a steep decline to the 6th day.

For oats: peak is on the 6th day, with low spots on the 4th and 9th day.

For rye: a slow ascending curve from 4th to 9th day.

Using plain water as control:

For wheat: a slow decline to the 7th day, small incline on the 9th day, the 5th day actually being the highest.

For barley: peak on the 5th day, steep decline to 6th day, slight incline on 7th day.

For oats: slight incline on 5th day, steep decline on 6th and 9th day, peak on the 7th day.

For rye: slight decline to 5th day, slight incline to 7th day, drop on 8th day.

The important finding is that, for practical purposes, one should select the date with maximum content. These dates, however, are different if different solutions for germination are used. The comparison of the three solutions — O, F, C — shows, in addition, that the development of protein can be greatly influenced by the proper use of a germination medium.

The *compost* solution has, in all cases, produced the maximum amount on the peak day. On the lowest day, the compost solution still has favorably exceeded the lowest value of the other two media (except rye on the 9th day).

The figures are as follows, selecting the highest value of the best day in each case:

Peak Day: *% protein on dry base* (*day in parenthesis*)

	Compost (*C*)	*Formula* (*F*)	*Control* (*O*)
Wheat	47.4 (6th)	43.8 (5th)	42.1 (5th)
Barley	31.6 (4th)	26.9 (5th)	25.1 (5th)
Oats	43.7 (6th)	39.0 (6th)	33.7 (7th)
Rye	45.7 (5th)	32.2 (9th)	31.0 (3rd & 7th)

It should be remembered that these are the figures *on dry base* on the green leaves; the appended tables also give the figures of the green leaves as received. From these we gather that there was a substantial increase of protein during the germination and the beginning leaf growth. Later on, when the leaves begin to stretch or elongate further, the protein content decreases, but at the first joint state of growth, it can still be between 20-30% (on a dry base).

This phenomenon points out that on the days mentioned above we have a maximum protein concentration which will never be reached again. The germinated grains, therefore, represent a protein feed of the highest order. Since the fluctuation is considerable from day to day, it is in the interest of maximum

efficiency, when using germinated cereal grains, to select the day which promises the highest contents.

The changes and fluctuation of protein contents during germination and initial growth are the result of powerful enzymatic processes. During the state of growth as selected for our investigation, an intensity of enzymatic process is observed which might not be matched at any other time of the plant's life. The storage protein and carbohydrates in the seed are broken down, transformed, and new synthesis (photosynthesis) begins. Hypothetically, it appears that even some carbohydrates are converted into proteins during the germination period.

The shifts in the *amino acid* pattern of the investigated amino acids furthermore suggest that the enzymatic processes take a somewhat different course, according to the kind of nutrient solution (C, F, O) which has been used. These shifts bring up the problem of protein quality. A protein, for instance, which is low in one of the essential amino acids, or such which promotes growth, behaves entirely differently in the digestion and nutrition of the animal or human organism which consumes the grain or seedling.

Lysine has the decisive position in the amino acid metabolism, for if lysine is low, the assimilation of all other amino acids is impaired. Arginine deals with the synthesis of hormone protein in the organism to be nourished. Glutamic acid affects the detoxification of the brain and the oxygen supply to the brain of the animal and human body. Leucine affects the enzymatic and endocrine efficiency of the organism. It has a decisive influence upon the function of digestive enzymes of the stomach, pancreas and small intestines.

Methionine deals with the fat metabolism. Threonine makes the entire anabolism efficient and therefore supports the uptake of nutrients from food. Tyrosine deals with the general metabolism and thyroid function. Valine supports the general protein metabolism.

The amino acid analyses which we have done so far indicate in all cases the favorable stimulating effect of the compost solution. A difference between root and leaf contents is seen too. The roots at this early stage of growth seem to live mainly from the proteins deriving from the seed, while the leaves begin immediately with the addition of assimilation products. The "peaks" and "lows" of the individual amino acids do not necessarily coincide with the "peaks" and "lows" of the total or crude protein.

In *wheat* leaves, most of the high spots of the C group coincide with the high of total protein. The case of lysine is especially interesting because it appears rather steadily in *wheat* roots, while it begins to show up in leaves only as a result of later assimilation. In *barley* it drops out completely after the fifth day. The pattern of *oats* follows very much the same trend as that of wheat. However, here the increase of lysine in roots must be due to assimilation and transportation from the leaves into the roots. The formula solution did not favor the formation of lysine, a fact which is also observed otherwise; for instance, all grains are low in lysine. Corn with excessive nitrogen fertilization produces an inferior protein quality.

For all other details we must refer to tables below.

PROTEIN CONTENT OF LEAVES

O = Control F = Formula C = B. D. Compost

Wheat:	% Moisture			% Protein As Received			% Protein On Dry Base		
Day after Germination	O	F	C	O	F	C	O	F	C
5th day	90.5	91.1	90.6	4.0	3.9	4.2	42.1	43.8	44.8
6th day	89.1	90.0	90.5	4.2	3.9	4.6	38.5	39.0	47.4
7th day	86.7	87.4	87.2	4.8	4.6	4.8	36.9	35.7	37.5
8th day	87.9	87.2	88.0	4.7	4.5	4.6	38.8	34.8	37.9
9th day	88.0	88.2	88.7	4.8	4.6	4.8	40.0	38.1	42.5
10th day	88.6	89.2	89.0	4.2	3.9	4.8	36.8	36.1	43.6
Barley:									
4th day	91.8	92.0	91.7	1.75	1.75	2.62	21.3	21.9	31.6
5th day	91.5	92.8	92.9	2.13	1.94	2.13	25.1	26.9	30.0
6th day	90.9	92.9	92.8	1.75	1.38	2.13	15.9	19.4	29.6
7th day	90.2	91.8	91.5	1.75	1.56	1.94	17.9	19.5	22.8
Oats:									
4th day	91.5	91.3	91.0	2.3	2.4	2.3	27.1	27.6	25.9
5th day	92.8	92.4	92.1	2.1	2.2	2.4	29.2	28.9	30.4
6th day	91.6	92.3	92.9	2.1	3.0	3.1	25.0	39.0	43.7
7th day	90.7	91.1	92.4	3.1	2.8	3.3	33.7	31.6	42.7
9th day	90.4	91.3	91.7	2.4	2.4	3.0	25.0	27.6	36.2
Rye:									
3rd day	89.9	89.6	89.7	3.1	2.8	3.1	31.0	27.2	30.4
4th day	90.0	91.0	90.5	2.8	2.4	3.1	28.1	27.1	32.6
5th day	88.1	89.4	90.8	3.1	3.1	4.2	26.1	29.3	45.7
7th day	88.4	88.5	88.6	3.6	3.5	4.2	31.0	30.4	36.8
8th day	88.9	90.3	89.9	3.0	3.0	3.1	27.0	30.9	30.7
9th day	89.2	91.3	90.9	3.2	2.8	3.1	29.6	32.2	30.7

The figures in the following tables indicate content in microgram per gram of leaf:

DAYS AFTER GERMINATION

Wheat:	5th O	5th F	5th C	6th O	6th F	6th C	7th O	7th F	7th C	8th O	8th F	8th C	9th O	9th F	9th C
Arginine	18	40	40	20	20	40	9	7	9	9	7	18	9	6	18
Aspartic Acid	15	20	25	25	25	40	20	14	40	30	20	50	30	35	50
Glutamic Acid	8	12	18	12	18	25	6	8	15	5	8	18	5	6	18
Leucine	1	2	5	2.5	2	10	1	1	5	1	2.5	5	2.5	2.5	5
Lysine	0	0	0	0	0	0	0	0	0	0	0	3	2	1.5	3
Methionine	3	3	5	3.5	5	10	3.5	2	4	1	2	4	2	3	3
Threonine	2	5	3	3	5	10	4	2	7	1.5	3	7	2	1.5	5
Tyrosine	0	1	1	0	1	1.5	1	1.5	3	1	2	3	1.5	1	2
Valine	0.7	2	5	0.8	0.9	1	0.7	0.1	1	0.7	0.7	5	0.6	0.6	1

Barley:	4th O	4th F	4th C	5th O	5th F	5th C	6th O	6th F	6th C	7th O	7th F	7th C
Arginine	7	9	9	7	6	7	7	6	7	7	6	7
Aspartic Acid	3	2	2	5	5	10	5	6	10	5	5	5
Glutamic Acid	2.5	3	8	2.5	2.5	6	5	5	8	5	8	8
Leucine	0.2	0.2	1	0.2	0.8	1	0.2	0.8	1	0.2	0.5	0.2
Lysine	1.5	1.5	1.5	0	0	0	0	0	0	0	0	0
Methionine	1.5	2	3	2	2	3	2	2	2	2	2	2.5
Threonine	2	2	5	5	10	10	5	8	10	5	5	7
Tyrosine	0.5	1	3	0	0	1	0	0	0	0	0	0
Valine	0.1	0.1	0.7	0.1	0.5	0.7	0.1	0.5	0.7	0.5	0.05	0.7
Oats:												
Arginine	9	9	18	40	40	40	9	9	18	18	18	18
Aspartic Acid	20	20	25	25	20	20	5	10	20	10	10	20
Glutamic Acid	4	5	5	8	8	8	5	5	8	16	16	18
Leucine	1	1	2.5	2.5	5	6	2	2.5	5	1	1	2.5
Lysine	0	0	0	0	0	0	0	0	1.5	0	0	0
Methionine	2	2	2	2	2	2	3	3.5	5	2	3	5
Threonine	4.5	4.5	4.5	4.5	10	20	3	5	10	10	5	5
Tyrosine	2	2	4.5	1	1	1	tr.	tr.	tr.	1	1	1
Valine	0.7	0.7	0.7	5	5	5	0.7	1	1	0.7	0.9	0.8

THE GROWING INSENSITIVITY OF INSECTS TO INSECTICIDES

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Translation, by Marjorie Spock and Mary T. Richards, of an article in Lebendige Erde, a periodical published bi-monthly at Stuttgart, Germany. The material first appeared in Medelingen v.d. Directeur van Tninbouw, December 1956.

A commission of experts on pesticides set up by the World Health Organization met in Geneva from April 10 to 17th, 1956. It is a well known fact that many serious human illnesses such as malaria, yellow fever and plague are carried by insects. Insects must therefore be eradicated to keep these diseases from spreading.

It was very difficult to do this prior to 1940, for there were no adequate means at hand. So there was great rejoicing when DDT and related compounds were discovered; the problem seemed solved.

But disillusionment soon followed and the jubilant chorus died away.

In the report of the above-mentioned commission, it is stated that ten species of disease-carrying insects have developed resistance to insecticides, and that a resistant tendency has already appeared in the case of twenty-seven others. All this in fifteen short years! And, as a matter of fact, it could have happened in less.

Sweden began an intensive DDT campaign to eradicate flies in 1943. Three years later the jig was up. The same thing happened in Denmark, Italy, Switzerland and some twenty-eight other countries. At first there was always amazing success, with the flies almost entirely wiped out. The problem was solved. And as time passed and things grew decidedly worse again, people blamed the trouble on a poorer quality of DDT or on carelessness in carrying out control measures or cold weather or other such scape-goats. No one was willing to accept the fact that the flies had become resistant. However, in 1947 or thereabouts, I was shown flies at the Pest Control Institute at Springvorbi, Denmark, disporting themselves in DDT as much at home as primitive sorcerers cavorting over red-hot coals.

"Well," went the comment, "all we need is a stronger concentration of the poison, or a different insecticide." American

investigators upped the concentration a thousandfold, and still the common housefly developed resistance to DDT, HCH, Dieldrin, Methoxychlor, Toxaphene, Chlordane, Heptachlor, Dilan, and even to some extent to Aldrin. Furthermore, quite a number of fly species, gnats, mosquitos, fleas, body lice, bedbugs and cockroaches — twenty-seven in all — became resistant to one or more insecticides.

The 'above' are all insects affecting human health. Now what of those affecting agriculture? Resistance phenomena have been observed in some twenty-five such species. A number of aphis, including the peach aphis, have already developed resistance to parathion, for example E 605. In the United States the Colorado potato beetle and the cabbage worm, Pexis rapae L., have become DDT-resistant. Enarmonia (Carpocapsa) pomonella L., (the codling moth) which makes apples wormy, is now resistant to both lead arsenate and DDT. Various harmful mites are resistant to parathion.

Resistance phenomena are actually not new in agriculture. Even in 1914, there were reports from the United States that the San Jose scale no longer reacted to a strong lime-sulfur solution. In 1916, many scales attacking citrus orchards in California were already insensitive to fumigation with hydrocyanic acid. Enarmonia's insensitivity to lead arsenate was well known in 1928. Just another proof that there's nothing new under the sun!

Entomologists long familiar with insect biology and also at home in palaeontology are not surprised at such developments. They know that in the many milennia of earth's history, numbers of plants and animals came into being and disappeared again, whereas insects were among the first living creatures on the earth, and none have ever disappeared. Biologically they are the earth's best-endowed offspring, the last word in the realm of living nature, where specialized adaptation is carried to the point of ultimate perfection. Every entomologist worth his salt knows insects to be man's most dangerous enemy, and involved in a life and death struggle with him. This fact seems not to have been borne in on Holland, however, for in no single Dutch university is there a chair of entomology, which I call disgraceful. Fortunately the Agricultural College has shown greater awareness of the situation.

The decision of the World Health Organization to call a number of experts together to study these problems was well

taken. But the calm that reigns in agricultural circles is really surprising. Every now and then something is said on the subject, but "shucks, we're getting along all right so far, and if the time comes when present substances don't work so well, we'll find something better." I do not share this optimism. As was pointed out above, insects that became insensitive to one insecticide were found to be resistant to others as well. The adaptive capacity of insects is nothing short of astounding. There is not a single milieu, not a single environment without some sort of insect life. Many insects are perfectly at home in derris-root, for example. They are found in the least likely medications on drugstore shelves. Many insects come to grief in the ponds of crude oil that form around drilling rigs in oil fields. The so-called petroleum fly considers them tasty morsels; its larvae live in crude oil and are nourished by the corpses of such of their fellow-insects as have ended there.

The insect world is nature's most astonishing phenomenon. Nothing is impossible to it; the most improbable things commonly occur there. One who penetrates deeply into its mysteries is continually breathless with wonder. He knows that anything can happen, and that the completely impossible often does.

But to get back to the case of our Danish flies, which seemed to take a positive pleasure in walking around in DDT: what had happened? Just about the same thing that we find in the case of potatoes and other plants bred and selected to achieve a desired end. There an attempt is made, through breeding and cross-breeding, to bring out as many good qualities as possible. The same thing happens with flies, except that while the qualities bred in them are advantageous to flies, they are certainly not so for man.

Control measures, in the case mentioned above, were very intensive, directed not only at the flies themselves but also at their larvae. Not a single species escaped exposure to DDT. The kill was therefore almost complete. A few specimens managed to survive, but observers who pointed this out were considered fussy; the survivors must somehow have escaped contact with the poison in spite of all precautions. No, they had not escaped it. The fact was, one kind of fly had been forgotten: the kind invulnerable to the insecticide, though exposed to it: the tough, resistant strains. There must have been two kinds of survivors: the unexposed and the resistant. The proportion of resistant specimens is probably the greater the more inten-

sive the eradication measures. This is very important, for it means that the survivors are pushed the faster in the direction of resistance the more the control measures are stepped up. Where quite a few unresistant specimens survive, the number of resistant descendants increases rather slowly. But the Danish eradication campaign was especially intensive, and so bred a highly selected host.

Not every species develops resistance for the same reason or to the same degree. Qualities responsible for insensitivity may be roughly divided into the following three groups:

I. Physiological resistance — the capacity to render the poison harmless by means of biochemical processes;

II. Morphological resistance — where, because of certain morphological factors, such as a thick skin, the poison does not penetrate so readily;

III. Resistance due to special modes of behavior, whereby contact with the poison is avoided.

The above is a very rough division. The problem is actually so complicated as to be little understood. One of the things known about flies is that they can transform DDT, Dichlor-diphenyl-trichlor-ethan into the non-toxic Dichlor-dichloraethan by eliminating one chlor atom of the DDT. All flies are able to do this, but most of them transform it too slowly to avoid extinction. Some just manage to escape, while others do so especially rapidly, and thus become extra-resistant. Others survive possibly because of a thicker skin, or because they continue flying and do not alight on DDT-covered surfaces. Following generations in some cases then unite these various resistant qualities and thereby develop an especially high degree of resistance. At this point a new attack is made on them, probably using a higher concentration of DDT. The results are obvious. These are the flies I saw walking around completely at home in DDT.

If the eradication program is halted, it is possible for resistance to decline gradually until it has reached its original level. Many cases are reported, however, in which this does not occur. This depends on hereditary factors. In most cases there is a certain decline, which stops short of the original level.

If eradication attempts are resumed, they are soon hung up again on the resistance factor. Our enemies have only grown stronger. In all such considerations we must keep clearly in mind that absolutely nothing new has developed. We are simply

dealing with a re-grouping of already existent hereditary factors achieved by cross-breeding and selection, a re-grouping favorable to the insect in question. The resistance noted is not a new development; it was already present. It simply appears in heightened degree in new generations, for these combine more resistant qualities than their predecessors. It is actually an arithmetical trick. It is difficult to say whether changes in genetic factors occur under the lasting influence of insecticides. If this is the case, the situation is very grave indeed. In my opinion we have to reckon with this possibility.

It could be of some interest to take an example of resistance ascribable to a certain type of behavior. Young codling moth caterpillars usually chew the skin of an apple before boring their way inside it to the core. If the apples have been sprayed with lead arsenate, these caterpillars die. Now it seems there were a few of these creatures that behaved differently and bored straight towards the core. Anyone can tell the rest of the story.

How to explain such scant attention being given these weighty matters, which some people even dismiss with a shrug?

It can probably be blamed on the fact that insecticide research is usually done by chemists and chemically-minded biologists, whose work too easily remains purely theoretical. The warning of that great student of heredity, Johannsen, to the effect that such research indeed involves mathematics but should not be confused with mathematics, has apparently been forgotten. Then too, many research men are too one-sidedly concerned with the question of the "median lethal dose," in other words with concentrations fatal to about 50% of experimental animals. This gives rise to such handsome comparative statistics and good-looking graphs! But once this sort of play starts, the animals in the experiment are conveniently forgotten. They are swept off the table, along with all the surprises and improbabilities that such living material always turns up.

I have never been an admirer of too much mathematics in biology. As long as twenty years ago, I sharply denounced the "median lethal dose" and all other such mathematical trickery. At the time I was accused of being an old-fashioned biologist, with no perspective — something I still occasionally have to listen to. Biologists who are solely concerned with laboratory experiments and graphs have forgotten that the word "biology" means "science of life," life with all its miracles, surprises and improbabilities. The biologist who is not always conscious of

working in the realm of the unexpected and the uncalculable is no true biologist. He is the victim of superficiality and materialism — sources of the most grievous error.

We have stared ourselves blind looking at the hundreds of experimental animals in our laboratories and at the probability statistics reached in calculating the "median lethal dose." Of course, nothing should be said against comparing two different insecticides, up to a certain point, just so long as one draws no absolute biological conclusions from these data. It is a more exact description to say that one is dealing here with improbabilities in the form of the one or two survivors out of an original million. These are results impossible to reckon out in advance, or to establish by laboratory test, but the biologist who has studied life as it really is could have prophesied these findings and warned of them. He will look for finer methods to reach his goal. Those who think that physics and chemistry suffice are in danger of losing touch with reality. But they are so far from realizing this as to be capable of asserting that things are going along pretty well right now and will continue to do so. The World Health Organization is less short-sighted, and for a good reason. Eradication campaigns undertaken on behalf of human health have been especially intensive, and thus have brought existing problems earlier to the light of day than has been the case in agriculture. In Holland, however, the time for caution is at hand. Soil management is intensive, and so are insect eradication programs. So long as there is a non-resistant insect population, things are manageable. When this is no longer the case, we will have plenty of trouble on our hands with respect to many insects.

Practical advice should therefore run something like this: *"Spray as little as you possibly can,"* rather than *"Spray to the limit of your capacity."*

There seems to be a tendency, especially in vegetable production, to spray and dust with abandon, completely disregarding well-founded cautions. The feeling apparently is, "If it doesn't help, neither can it do much harm." But it decidedly does do harm. One should therefore make absolutely sure that eradication measures are indicated before attempting them. There should be much more research as to whether this or that insect or other creature is doing any real harm, and how much harm, recognizing that it is more sensible in some cases to take a small amount of damage in preference to having none for a

time but paying for it in the long run by losing the very means of fighting.

Our Plant Pest Control Service in Wageningen is giving this problem very serious attention. But it is by no means easy to establish the facts experimentally. Much remains to be learned. Perhaps most important is the experience of able and knowledgeable farmers and gardeners, who well realize that we can't mechanize every last thing on earth.

We consider it part of our counselling service to keep pointing out these facts and warning of the dangers connected with exaggerated use of insecticides.

We have a good example of the probable solution in the present campaign to control malaria in the province of North Holland. Spraying is done only in those houses where malaria patients live, thus attacking only a small percentage of the mosquito population. There may, of course, be an infected mosquito or two flying about in some other places as well, but this small risk is not too big a price to pay in view of the fact that in this procedure no mosquitoes are rendered resistant.

After beginning this report, I received a Danish article stating that when a dead end was reached with DDT, an intensive campaign using parathion and other phosphorus-containing insecticides was launched. This too is already running into trouble.

It is more than clear that we are traveling a dangerous road. So far we have mentioned the resistance factor only. But there are other dangers inherent in chemical control such as — for example — the destruction of natural predators of harmful organisms. I am afraid that weed-killers too will get us into trouble, probably sooner than one might suppose.

We are going to have to do some very energetic research on other control measures, measures that will have to be biological, not chemical. *Our aim should be to guide natural processes as cautiously as possible in the desired direction rather than to use brute force.*

An example of the cautious approach is the prescription to rotate crops in dealing with the problem of potato nematodes. Further aids are found in the attempt to breed resistant types of potatoes and to lure nematodes away from potato fields with baits and attractants.

Compared with methods such as these, the application of nematode poisons is brute force that could be costly in the end.

We need a more high-minded orientation and a deeper insight, which I miss in many researchers. Life is a miracle beyond our comprehension, and we should reverence it even where we have to struggle against it. It is a fact that the resort to weapons such as insecticides to control it is a proof of insufficient knowledge and an incapacity so to guide the processes of nature that brute force becomes unnecessary. Humbleness is in order; there is no excuse for scientific conceit here. When we can find the proper method, such as those described above whereby the potato nematode was more or less successfully dealt with, it is irresponsible to use insecticides. We should resort to these only when no other solution can be found, and then only with all proper caution. Pressure on the pest population should always be as slight as possible.

We are dealing here with fundamental laws of nature over which man too is powerless. All living things strive to maintain themselves against damage and oppression. The strongest and fittest are the ones that survive such struggles. Populations not constantly exposed to pressure are rendered weaker and often become extinct. Evolution and development are unthinkable without what we might call damage and misery. Thus also, the greatest danger to the human race is not its dilemmas, but rather its well-being. *We must therefore fear that in a hundred thousand years human beings could become extinct, but certainly not insects.*

Our dilemma could make us wiser. In pest control we have been made somewhat wiser already by the resistance factor. Some of the above-discussed facts were taken from a lecture by Wiesmann, a research scientist at the Geigg Corporation, the home of DDT products.

Let us hope that agriculturalists and orchardists will recognize these dangers in time and become less indiscriminate in the use of insecticides.

1958 GOLDEN ACRES FARM CONFERENCE

Working farmers and gardeners in the B. D. movement will want to note down the dates October 17th to 19th. This is the week-end of the annual B. D. Farm Meeting at Golden Acres, Newtown, Pa. While the detailed program is not yet made out, it is suggested that those interested in accommodations contact Ernest Fetzer at Fetzer's Farm, New Hope, Pa. The meeting at Golden Acres begins at 8 P. M., Friday the 17th.

THE EARTHWORM IN GENERAL — THE COMPOST WORM IN PARTICULAR

HEINZ GROTZKE

With regard to our nutrition, we consider the plant, which provides the foundation for the existence of animal and man, as the beginning of the organic-living. Usually, the plant is not thought of as a whole, as a bi-polar entity that stretches forth leaves and blossoms to the sun, to the cosmos — and at the same time sends down a multitude of roots into the dark earthly realm. Now the soil in which the plant is rooted does not consist only of weathered minerals, in addition it stores organic refuse in all stages of decomposition. These organic components of the soil are the dwelling places of countless organisms, which find their nourishment in them. In a short time the soil organisms start a decay of the organic substances, and by this means prepare them for being taken up by the plant roots, which are able to get *their* nourishment from the products of decomposition. Seen in this way, the plant is dependent on the activity of the soil organisms in the same way as man and animal are on the plant world. In line with this, the beginning of the organic-living is to be seen in the millions of organisms that inhabit our soils. The number of species of soil organisms is very great, yet one stands out because it exceeds all others in terms of weight: the earthworm. In terms of a unit of surface, the total weight of the earthworms in the soil is supposed, in good years, to equal the weight of all the living mammals on the surface, including human beings.

The significance of the earthworm for soil building was recognized by the scientific world after Charles Darwin, in 1881, published his book "The Formation of Vegetable Mould through the Action of Worms". Yet already in 1877 Von Hensen wrote a paper on "The Activity of the Earthworm for the Fertility of the Soil", and in it demonstrated the value of this creature of the soil in the formation of humus. (Darwin's earliest statement on the subject, a paper read before the Geological Society of London in 1837, stirred up controversy in the scientific world. He continued observations and refers to Von Hensen's paper as making many of these superfluous, yet felt that he should gather all the material together in book form as a final statement. *Ed. B-D.*) In the years since then, and right up to the present, knowledge concerning the earthworm has been increased, and experiments have repeatedly demonstrated its usefulness.

Biologically, the earthworm is a hermaphrodite, male and female reproductive organs developing in every worm. So a mutual fertilization takes place, in which the ringlike part known as the clitellum serves to surround the partner. The fertilized egg capsules, which, depending on the variety, can contain up to 20 young, are deposited underground. The living young slip out of these after 2 to 3 weeks, the time being contingent on the degree of moisture. The time span from leaving the egg to sexual maturity differs according to the variety. It is shortest in the case of the compost-worm (Eisenia foetida), amounting to about 80 days.

Since numerous earthworms are present in almost all soils, their activity has a great influence on soil structure. While in the main it is the bacteria and fungi in the earth that start the decomposition of organic leftovers, these are joined to mineral substance in the intestine of the earthworm, and there a stable humus in the form of clay-humus complexes is produced. The bacteria are not killed off in this process, on the contrary they find beneficial life conditions in the earthworm excrement. Besides, in the course of the mixing in the earthworm intestine, the organic-mineral components are enriched with lime, which is added by certain glands. This takes place to such an extent that the excretions always show a neutral reaction even though the raw material often shows an acid reaction. The formation of lime substances in the earthworm intestine cannot yet be explained scientifically, possibly because they come into being in an organic way as a result of cosmic influences.

In contrast to the other soil organisms, the earthworm not only works through the ground horizontally, but its activity also reaches down to the deeper layers. This takes place particularly in summer and in winter, when dryness or cold cause it to retreat into these regions. Not infrequently it reaches a depth of 2 meters (about 6½ feet), and it has even been proven that the earthworm has gone down as far as the water-bearing layers of the ground, and reached a depth of 8 meters (about 26 feet) in the process.

Seen biodynamically, the earthworms have a further beneficial effect on the soil, in that they regulate the etheric formative forces in the earth. After a heavy rain that penetrates deeply into the ground and thus enriches it with the etheric, the earthworms come up to the surface and thus, by means of their passageways, open the soil towards the top so that an excess of

etheric forces can escape. Dr. Steiner pointed to the importance of this in his Agricultural Course.

As an organism that is physiologically dependent on darkness and moisture, the earthworm only leaves the soil of its own accord when outer circumstances compel it to do this. When the tunneling activity of a mole is going on, we may observe how the worms seek hurriedly to reach the surface of the earth. The mutual copulation also takes place above ground during the night.

The density of earthworm population in different areas of ground varies greatly. Soil moisture and the amount of organic constituents are the determining factors here. In the whole landscape, the woods are the most favorable dwelling place for them, next in order of density of population come meadow, garden and ploughed field. The earthworm will not be encountered in a pure sand soil. The main reason for this is the poor water-holding capacity of such a soil. Besides, the worm appears to need clay constituents in the soil, for its digestive activity, for if a small amount of clay or loam is added, it will also live in sandy soils.

The usefulness of the earthworm in the soil is universally recognized, yet until now there has been little investigation as to how much of a direct increase in yield a soil occupied by worms produces as against one poor in worms. The only one who conducted experiments on this subject was Dreidax*. A parcel of land that was occupied by earthworms brought an increase of grain kernels of 7.4% as against the control field. A worm variety that lives in ploughed fields was used for the experiment.

The statement immediately above would indicate that there are various kinds of earthworms, which inhabit specific types of ground. In Germany, about 30 varieties are known and have been investigated. When Carl von Linné published his "Systema Naturae" in 1735, only one sort of earthworm was known to him, the one that is still today called Lumbricus terrestris. Later all the European varieties were called after it, with the common name Lumbricidae, in contrast to the tropical and subtropical varieties. The Lumbricidae are today found spread over the whole earth in the temperate zones. In our meadows and pastures there are represented worms of the species Lumbricus, Allolobophora, Octolasium and Eisenia. To the latter belongs the manure worm Eisenia foetida, which plays an im-

* One of the B. D. pioneers.

portant role in connection with the development of our biodynamic composts, and which we will consider in more detail in what follows.

A worm of the variety Eisenia foetida is also called a compost worm, because it can only live in a material in which the organic constituents make up more than 30% of the total. The compost worm has a number of advantages, as against other varieties, which make it suited for introduction in the composting of organic waste materials. Because of its dependence on organic substance, it stays in the compost without moving off into deeper soil layers as other varieties would. Its development period of 60-80 days is the shortest of all varieties and provides for a quick increase. Its consumption of food is relatively high, and yet not bound to a limited range of acidity in the materials.

All the advantages of this variety of earthworm were soon recognized by observant investigators, and farms developed — primarily in the U.S.A. — that undertook large-scale breeding of them and sold the worms or their egg capsules. There were and still are hybrid-worms offered for sale, that are supposed to be a product of a crossing of the compost worm and a variety that is found in cultivated fields. Their special advantages are supposed to be a quicker consumption of the refuse materials along with the ability, after having been brought out onto the fields, to continue living there. Yet these results cannot be taken too seriously, since in all probability these are simply well-nourished specimens of the variety Eisenia foetida.

In our biodynamic composts, the compost worm — provided it exists in the neighborhood — in most cases comes into the heap by itself after the high initial temperatures in the compost have subsided. Yet its appearance and its activity should not be left to chance. Its many-sided utility makes it requisite also from the biodynamic standpoint that it be bred and inserted into the decomposition process of the organic refuse materials in a controlled fashion.

For this reason, an earthworm-breeding establishment was developed here* which appears to meet all requirements, and to be equally well suited for the farmer and the gardener. For farm use, the plant is composed of several square sections (4 feet by 4 feet) formed by boards shoved into slots in cement posts. This arrangement makes it possible to work up easily in a small space whatever amount of organic refuse is available.

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* At Golden Acres Farm, Newtown, Penna.

The finished material can be removed from the sections by hand labor or with a front-end loader, simply by lifting the boards that wall in the sections. The damage to the worms is thus held to a minimum. The boards, which are all of equal length, can be quickly changed, and can be stored in a dry place when not in use. The plant can be easily enlarged or made smaller as needed. For its location, it will be advantageous to choose a place shaded from the noonday sun.

The advantages of such an earthworm establishment can also be enjoyed by the small gardener, for whom one to two sections will suffice. The accumulation of organic refuse from the kitchens and manure from the small animal stable is only slight, and often not sufficient for piling up as a compost heap. With an earthworm-breeding set-up, however, every accumulation, no matter how small, is immediately worked up, furnishing as end product a concentrated compost. For the professional gardener, who is dependent on the purchase of organic fertilizer, such an establishment can be used to transform the fertilizer into earthy substance. This finished material is especially suitable for the culture of young plants, since it shows a neutral reaction and the plant-nutritive materials are organically built up. It is easiest for the farmer to maintain an earthworm plant, for he has available on his place various sorts of fertilizers and organic refuse which can serve for the nourishment of the worms. We will speak later about the utilization of the finished material for larger areas.

On practically all farms, and wherever organic refuse is made into compost, there are so many earthworms of the variety Eisenia foetida that the breeding plant can be started with them. They are externally recognizable through their reddish-brown color and the clear presence of a ring — generally lighter in color. The length of this worm depends on its age and nutrition, but averages 2 to 3 inches. Where this variety does not live on the place or does not establish itself, it is easily obtainable from other farms or through purchase. The stock of worms forms the strain from which tens of thousands and more should develop. The operation is started on a piece of level ground, and in order to avoid stagnant moisture, no soil is removed from the breeding sections. For the same reason, the ground in the sections is spaded after the boards have been shoved into the slots in the cement posts. The worms are placed in the various sections and immediately covered with moist, organic material.

With this operation a beginning has been made in the breeding of earthworms, the goal of which in the first months is a quick increase.

To reach this goal, the establishment needs a certain amount of care which, however, actually takes little time. There are three factors to which attention should be paid. First, the substance in which the worms are living must always be kept moist, second, there must always be sufficient organic material at hand for them to eat, and third, the worms must be protected from enemies and injurious influences.

Since the life of the earthworms depends on moisture, a breeding plant must certainly be watered in the summer in times of continued dry weather, to prevent their dying off. Yet over-watering should be avoided, since useful bacteria and nutritive substances are carried away with overflowing water. As far as the living conditions of the earthworms themselves are concerned, over-watering is made impossible through the nature of the construction, since any surplus of water goes out between the boards, as can be seen during heavy rainfalls. The degree of moisture present can be determined by feeling the top layer, which should be completely moist. The appearance of ants in the sections is always a sign of dryness.

After the worms have become observedly abundant, the matter of their feeding becomes of the utmost importance, since increase in numbers is to a large extent dependent on the food supply. The organic refuse is layered into the individual sections, at which time it is most advantageous to sprinkle them with earth. Then no putrid odor will appear, and the appearance of flies will also be prevented. The earth accumulated in digging the holes for the cement posts can be used for this purpose. If the earth spread on the layers does not itself contain clay, the addition of a small amount is necessary. The worms settle in the added layers after they have worked through the lower ones. If they are found in great numbers just under the surface, that is a sign that new food needs to be brought to them. An exception to this is when the worms come to the upper layers during a heavy rainfall in order to ensure the necessary ventilation. All organic refuse can serve as nourishment for the worms, whether it comes from the kitchen, garden or stable. It should, however, be in a moist state. When decomposition begins, the material is attacked by the worms and worked over. Refuse to which traces of poisonous pest-control materials cling

is only gone at months later, after the poisonous effects have weakened.

An earthworm culture attracts many an animal. Foremost of these can be the mole, which tries to get its nourishment here. But such an invasion is easily noted, and can be turned away by setting boards into the posts to a depth of 8 to 12 inches below ground level, or sinking strips of corrugated sheet-iron into the ground around the outside. In winter, the worms must be protected from every frost, since only a few degrees below the freezing point bring about their death. The most practical thing is to set up bales of straw along the sides of the area, and fill the sections with loose material such as leaves, hay or the like. Before doing this, it is advisable to put down a layer of manure, which can serve the worms as winter food. During mild weather they go on working in winter.

The earthworm is particularly attracted by certain plants, including valerian, the onion family, phlox, wild cherry and hornbeam. Knowing this makes it possible to use refuse material from these plants and trees in the food for the earthworms. At the same time one should leave out those which are shunned by the worm. These are sage, thyme, wormwood, and trees of the Robinia family, such as the black locust. The biodynamic preparation made of valerian can be used with excellent results for the cultivation of earthworms. Sprayed in the usual dilution, over the sections, its effect fosters the health and reproductive capacity of the worms.

There are two things produced in an earthworm plant which can be called end products: the castings of the worms and the worms themselves. The earthy material in the sections represents a humus-rich compost in concentrated form. The bacteria content is very high, and thus fertilizing an area with this substance is effective not only as an enrichment of the soil with plant-nutritive materials, but also by increasing the soil life. Spring is the best time to empty the sections, which are left over winter to give the worms room to retreat from the cold. When the temperature starts to rise in spring, the worms go into the newly spread layers of organic material and can be lifted off with these. It is of little use to take the worms out to the fields along with the composted material. They would die, because they are dependent on an environment of high organic content.

The yearly accumulation of earthy substance from an earthworm plant is not large enough to fertilize all the fields of a

farm. Even if it were possible to have enough for this purpose its high moisture content would make it too heavy for ease in spreading. For these reasons, spreading in liquid form seems to be the most suitable. A further advantage of this method is that almost all the worms and their egg capsules can be held back. If the excrement of the worms is dissolved in water and brought to the fields as a liquid manure, this will not be lacking in result. The castings are carriers of the most important plant-nutritive materials, and at the same time the trace elements are also present in them in high dilution. They are all bound together with humus, and their existence can therefore be described as organic rather than mineral. Such a relationship with humus always exists for the lime in the castings, which comes from the glands of the earthworms and thus has come into existence in an organic way. A watery solution of the castings therefore contains organic lime effects, and similar effects go out from the individual plant-nutritive materials that are part of the excrement. Added to this is the fact that a great variety of humus-building soil bacteria has developed in the excrement. These enter the soil with the solution, and are active there in connection with the digestion of the organic residues in the soil. Use of the earthworm castings, as it has been described here, represents a homeopathic dose for the soil, one which combines all sorts of beneficial effects for plant growth. It has not been possible to assemble an adequate body of experiences as yet for presentation here, but probably such data can be published in the course of the next year. The purpose of this article is to stimulate similar experiments, which will perhaps come to the same results.

After a certain length of time the worms in an earthworm culture will, under optimal conditions of moisture, temperature and nutrition, have increased to such a degree that worms can also be removed from the installation. At this point one could enlarge the plant by stocking new sections with these worms. A further purpose for an earthworm-breeding plant can be that of raising worms as a protein-rich feed for poultry. Besides the nutritive content of such a feed, there are in it, because of its high bacteria content, antibiotic effects which develop disease resistance in the poultry. It has been observed that not only are the worms themselves eaten, but also the earthy substances in which they live. The reason for this lies in the livingness of the worked-over material. In this department also, not enough reports of experiences are available as yet.

In line with the foregoing, the editors suggest that it would be of great value if factual reports of earthworm experiments and experiences, particularly in connection with the utilization of the castings and the use of surplus worms for poultry feeding were sent to Mr. Grotzke.

THE ERLANGEN COMPOST PLANT

Just about one year ago, in mid-July, 1957, Dr. E. E. Pfeiffer conducted a group of experts and officials through the garbage composting plant constructed under his supervision at Erlangen, Germany. The next day the Erlangen Tagblatt, one of the local newspapers, carried a story about this visit. A condensed translation of this article follows. Another paper, the Erlangen Nachrichten, also wrote favorably about the plant.

The Tagblatt article was headlined:

FOR THE FIRST TIME IN GERMANY:
VALUABLE SOIL FROM GARBAGE CANS

In this connection it is to be noted that while there are other systems used in various places in Germany and Holland, the plants were reportedly rather complicated and expensive and their product was said not to come up to the requirements of the farmers and gardeners. The Tagblatt stated, in part:

"The plant was constructed under Dr. Pfeiffer's supervision, with the cooperation of corporations from Cologne, Germany, Philadelphia, Pa., U.S.A., and the Siemens-Schuchert Company. Previously, at the lecture hall of the Central Administration of the Siemens-Schuchertwerke, Dr. Pfeiffer had explained the principles of his biological process in the presence of the Lord Mayor Poeschke, Chief Building Counsellor Bauer, State Counsellor Beckh and other representatives of the government of Mittelfranken.

"The Erlangen project originated due to ideal teamwork. The City reasoned that, because of the increased building activities in its periphery and nearer environment, there were less and less dumping places available, so that in the near future one would have no more space to dump garbage . . . 2,000-2,500 cubic yards every month—during the winter even more—are piling up . . . . Therefore the City of Erlangen would be willing to spend DM 200,000 to 350,000 for a complete processing plant if the

pilot experiments, which are planned for three months, are successful.

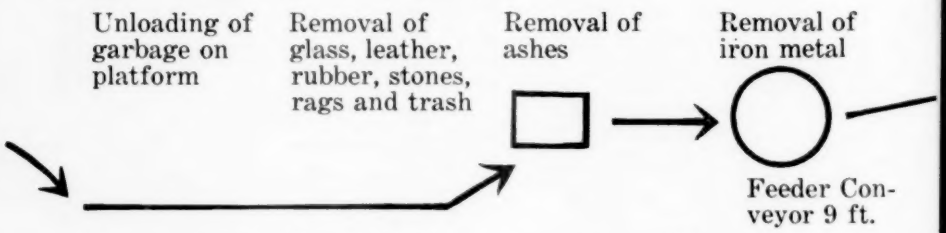
"Under the assumption 'garbage is garbage,' one might think that the pilot plant, which cost some DM 60,000 to 70,000, would not be necessary inasmuch as Dr. Pfeiffer has obtained good results with his process in the Azores and in the U.S.A. However, the garbage in the U.S.A. contains much more paper, while in Erlangen the high amount of trash (and ashes) needs special attention. Garbage is quite different, even according to the sociological structure of various city precincts. Also, climatic conditions play a role. While during the strong heat period the fermentation time was shortened by one week, one can assume that during the colder season the fermentation will take a little longer. These are all problems which had to be worked out at the location itself.

"Nevertheless, the principle of the plant always remains the same. The construction elements are kept decidedly simple. All electrical motors are operated from one central position. The garbage is dumped as it is collected. On a short sorting belt, all non-compostable materials are removed. These include trash from buildings, machine shop refuse, glass, leather, rags (which have salvage value there). A vibratory screen removes ashes. A magnetic separator removes iron and other metals and tin cans (salvage value). The separated garbage is run through a grinder (Williams, St. Louis), of which there are different models with capacities of 1, 5, 10 or 20 tons per hour. During the grinding, the most important link of the process is added, the Starter-Bacteria-Cultures. These are applied with a spray distributor in order to induce the desired biological fermentation. Ten thousand bacteria, at least, per cubic millimeter, attack the material. In order to find suitable cultures, Dr. Pfeiffer has for many years investigated all kinds of soils of various continents, and studied the root areas of many different sorts of plants. The balance of each soil is determined by its micro-organisms. The most suitable organisms were exactly investigated with regard to their chemical properties — which material, and how much in a given time, they are able to decompose.

"In the fermentation, which is carried on in two phases, are contained processes which decompose the source materials. The first step is a hot fermentation, 145-166°F., for four to ten days. Then follows the cold or humus fermentation.

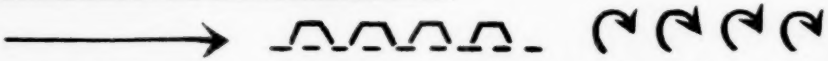
FLOW PLAN: GARBAGE COMPOS

1. MECHANICAL PREPARATION


Unloading of garbage on platform
Removal of glass, leather, rubber, stones, rags and trash
Removal of ashes
Removal of iron metal
Feeder Conveyor 9 ft.
Accepting conveyor 15 ft.
Sorting belt 12 ft.
Rotary or vibratory screen 6 ft.
Magnetic separator, fully automatic, about 4 ft.

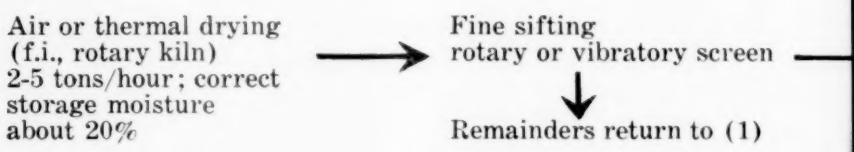
Process 1: Running distance about 58 feet — time 1-2 minutes
Capacity according to site of grinder:
HP needed: 14 HP for conveying:

2. BIOLOGICAL FERMENTATION:


From the mechanical processing to the compost piles
Setting up of fermentation piles with dump truck. Time of fermentation hot (initial phase) 4-10 days
Turning of piles with overhead loader 20-60 tons/hour, 1-3 turnings

Process 2: 14-28 days, according to climate and season (average 21 days)

3. FINISHING OF FERMENTED COMPOST:


Air or thermal drying (f.i., rotary kiln) 2-5 tons/hour; correct storage moisture about 20%
Fine sifting rotary or vibratory screen
Remainders return to (1)

Process 3: according to capacity of equipment

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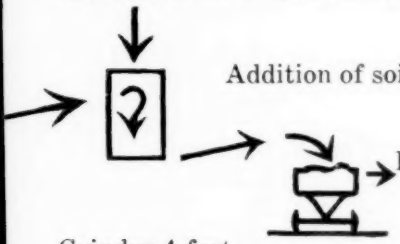
PHILADELPHIA 2, PA.

ING PLANT, ERLANGEN, GERMANY

Addition of B. D. Starter Solution



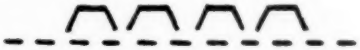
Addition of soil (10% of total garbage weight)

Dump truck to compost fermentation area

Grinder 4 feet

Take away conveyor 9-12 feet

1, 5, 10, 20 tons/hour
30, 50, 100, 200 HP for grinding



Cold and humus fermentation
10-18 days; phase 2

Loading finished compost

Storage in the open
or underneath a roof

Bagging and shipping

THE PFEIFFER PROCESS IS THE PROPERTY OF
THE GENERAL COMPOST CORPORATION, INC.
PHILADELPHIA 2, PENNSYLVANIA

"The humus at the pilot plant in Erlangen, which today is 14 days old, is already usable for purposes of fruit, vineyard and forest cultivation. For use in gardens, it has to be 3 weeks old.

"Experiments have demonstrated that the fertilizer value of compost made according to the Pfeiffer process is two to four-fold that of barnyard manure and has — probably because of its nitrogen fixation — tenfold more efficiency than other composts. The City of Erlangen now has to decide whether they want, as the first city in Germany, to build the compost plant for garbage composting."

There follows here the Flow Plan of the Erlangen plant described in the above article.

* * *

B. D. COMPOST STARTER RECIPE FOR SMALL GARDENS

Our old friend, Mrs. Louis L. Browne of Pennsylvania, sends this description of how she uses the Starter for her heap.

1. For daily collection of kitchen garbage — a small covered container.
2. When the refuse begins to accumulate, place ¼ teaspoonful of B.D. Compost Starter in ¼ cup of warm water to soak for 12 hours before using.
3. In a day or two this kitchen garbage is put into a pail in the garage, the Starter sprinkled over it, making sure that all the good bacteria are rinsed from the cup, so they can get right to work on their jobs.

By the end of a week, when a helper comes, he spreads this collection on the building compost heap, adds the grass cuttings and chopped up weeds, dusting a little lime over it and covering it with a thin layer of soil. In covering, the center of the pile should be slightly lower than the edges to catch the rainfall and hold it.

The B. D. Compost Starter and further information about it, including detailed instructions for building a compost pile with the Starter can be obtained from the BIOCHEMICAL RESEARCH LABORATORY, SPRING VALLEY, NEW YORK.

FROM ROSINA ARNDT'S NOTEBOOK

Mrs. Arndt, who has contributed to Bio-Dynamics in the past, is a steadfast B.D. farmer in the Ozarks.

I find it good practice to prepare in one of my better fields, having a clay of high exchange capacity, a backfurrow of treated soil in preparation for composting; that is, in addition to the stockpile of soil brought to the composting yard in fall. It has been practicable to do this on the level drawn for contour-strip-cropping. The soil is sprayed with Preparation No. 500, a good, strong backfurrow thrown up, and sprayed again. A portion can be mulched with straw to keep it accessible during freezing weather. The mere elevation above the surrounding plane is in itself beneficial; the application of 500, and the drainage of the backfurrow keep it friable long after one can't touch soil anywhere else.

It is a wonderful convenience in winter to scoop up this living, humus soil and to dress a larger accumulation of manure in a one-handling operation at a time when it is so easy to slight this so important step in the composting process.

* * *

On my Ozark hill farm the site of Stone Age Man's workshop is the indicator for logical wheat ground: a brown forest soil over a very fine clay over limestone layers. It is a soil that does not easily erode, and that has been unfailing wheat ground for 150 years. The field enjoys a SE exposure with windbreak of virgin timber NW. I still find quite good artifacts of hematite and flint in addition to the chips and pieces of the workshop.

* * *

Judges 9, 15. And the bramble said unto the trees, If in truth ye anoint me king over you, then come and put your trust in my shadow:

Is it this relationship that provides the bramble the amazing success it enjoys in reforestation even in the middle of a permanent pasture? The briars will spring up in patches most anywhere, vital and assertive, not to be denied. They provide a safe haven for birds and wildlife, they produce a tonic, astringent berry for man's use. Cattle browse them gratefully, but will not penetrate the thicket. In this seclusion a black locust (also a favorite browse) or wild cherry seedling will grow away until it is out of reach of the cattle. Then Natura uses a blight to wipe out the briars, and we have a heavily-mulched area under

(very often) a grass-friendly leguminous tree, the landscape has a friendlier aspect, the cattle have shade, and the bramble has justified the trees' trust in her.

* * *

BOOK REVIEW

"You operate a 'field factory'"

The final chapter of Glenn C. Klingman's thorough, authoritative and most interestingly written *"Crop Production in the South"*, (John Wiley & Sons, Inc., New York, $4.95), states and develops the above theme. It runs, of course, through the entire book. The author, Professor of Field Crops at North Carolina State College, dedicates his work "to furthering the scientific training of young men studying agriculture in the South". He does a magnificent job in presenting, first, the basic sciences the future farmer needs to have some understanding of before he is ready to hear about problems of soil management, plant breeding and crop production. And when he goes on to specific crops he rightly stresses the economic aspects along with the natural-scientific. (The book was written with the editorial assistance of Lyman J. Noordhoff, Information Specialist, U. S. Dept. of Agr.).

Yet, is not the whole *tragedy* of our modern agriculture summed up in the "field factory" concept? True enough that our farmers, the good, efficient farmers, are, by and large, making money. Also, our population is, from a certain point of view, very well fed, in fact the best fed in the world. No sane person would quarrel with the author's stress on the scientific and economic aspects of farming. Furthermore, his work, intended primarily as a text-book for Southern agriculture students, would be most salutory reading for the "organic farming and gardening" *enthusiast* who, all too often has got a hold only on "the other end of the stick".

But the *tragic* aspect remains. If there is in the book any reference to the creative aspects of farming, to farming as an art as well as a science, the undersigned could not find it. Yet any scientist will tell you that the *phenomenon of life itself* is beyond the grasp of modern natural science. And really successful farming over a period of years, farming that produces crops consistently high in nutritional value as well as volume of yield, depends on at least a degree of practical understanding of, and working with this same phenomenon of life.

Ask any honest-minded commercial apple-grower, for in-

stance, and, best of all, one whose father was in the same line of work before him. He won't make any references to "life phenomena" but he will recall, with genuine sadness, not only how the regular increase from year to year of poison sprays coincides not with less but with more insect pests to be sprayed against. He will tell you, too, how in his boyhood the "primitively" stored apples stayed fresh and delicious far into the following year while nowadays, despite the excellent facilities for temperature and humidity control, the fruit all too often seems to lose its quality all too soon.

Professor Klingman "disposes of " the entire Organic Agriculture concept in a few sentences on pages 16 and 17 Discussing the question "Where do plants get their substances?", he writes:

"Long before man began experimenting, he figured out two speculations or guesses, even though wrong, regarding this question. The older idea was to the effect that plants derived all their substance from water. Probably the fact that plants wilted and soon died without water accounted for this reasoning. The second guess was that plants fed upon decaying animal or plant matter in the soil. Possibly the large, healthy plants found near animal droppings accounted for this belief. We still have a few people today who believe that only decayed animal or plant materials can produce healthy plants. They maintain that 'chemical fertilizers' will not grow healthy plants. Fortunately for agriculture this is not true. Actually we have only some organic material available at low enough cost to maintain a high state of soil fertility."

The essence of the argument appears, finally, to be that organic matter is perhaps as good as "chemical fertilizers" but it costs too much. The work of those who have shown scientifically and in practice that the balanced farm can produce its needed organic fertilizer — supplemented in the case of special deficiencies by small amounts of specific chemical materials — on an economically sound basis, is disregarded without, apparently, bothering to investigate the data. The further fact that growers such as the big vegetable producers, who are obviously not in the position of a balanced farm, could be sufficiently and economically supplied, through municipal garbage composting plants operating with a tested and proven process, is apparently ignored or else not known to the author.

FRED HECKEL

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